



2018 Tree Canopy Study

Date: December 18, 2019

To: Infrastructure and Environment Committee

From: General Manager, Parks, Forestry and Recreation

Wards: All

SUMMARY

The 2018 Tree Canopy Study provides an update to Toronto's first tree canopy study, *Every Tree Counts: A Portrait of Toronto's Urban Forest*, published by the City of Toronto in 2010, and later updated in 2013. A decade has passed since the original study was undertaken. The 2018 update offers an opportunity to evaluate what has changed in Toronto's urban forest over the ten-year period. This type of tree canopy study is an important part of the adaptive management cycle for Urban Forestry. It allows City staff to work with up-to-date and reliable data to adjust program activities that reflect the changing nature of the urban forest and evolving management issues.

Using established methodologies developed by the United States Department of Agriculture (USDA) Forest Service, together with improved data analysis software, the 2018 Tree Canopy Study provides information about broad changes and trends in Toronto's urban forest over time. It provides data on the extent, size class, composition and condition of the urban forest. It also provides insight on land use changes and trends across the city. Additionally, it offers information about the amount and dollar value of several key ecosystem services provided by the urban forest.

Summary of the 2018 Tree Canopy Study findings:

- Toronto's canopy cover increased from 26.6 - 28 percent in 2008 to 28 - 31 percent canopy cover in 2018, representing an increase of 10.2 million to 11.5 million trees.
- Street trees make a significant contribution to the urban forest; increasing from 49 percent to 74 percent rated in good/excellent condition.
- The composition and condition of the urban forest has changed; while there was a slight increase in larger-growing species, the overall condition of the urban forest has declined and invasive species are increasing across the city.
- Impervious land cover is increasing across the city; trends show increases in impervious surface cover across all land uses, however the largest increase being found on single family residential lands.

Over the last decade, the City has invested \$605.6 million in Toronto's urban forest, a steady annual increase from 2008 to 2018. Under the guidance of Toronto's Official Plan, the City's growth strategies related to transit and housing are balanced with

environmental sustainability objectives, including urban forest sustainability. The City's strong commitment to maintaining, sustaining and growing the urban forest has directly supported the generally positive trends seen in the 2018 Tree Canopy Study. The estimated 1.8 percent canopy increase is a tremendous finding given the intense challenges experienced by Toronto's urban forest over the last decade, including the devastation by forest pests, particularly Asian long-horned beetle, Emerald ash borer, and European gypsy moth; the impacts of the 2013 ice storm; and the city's intensive development and growth.

As the 2018 Tree Canopy Study presents findings only, there are limitations to the extent that a cause-and-effect relationship can be established at this time. City staff will continue to review the findings, analyze both positive and negative trends, and use these to inform ongoing urban forestry program planning through relevant City strategies and initiatives, and operational management adjustments including the strategic allocation of resources through revisions to the Urban Forestry Service Plan.

RECOMMENDATIONS

The General Manager, Parks, Forestry and Recreation recommends that:

1. Infrastructure and Environment Committee direct the General Manager, Parks, Forestry and Recreation to use the findings included in the 2018 Tree Canopy Study to inform ongoing urban forestry program planning and strategic resource allocation through revisions to the Urban Forestry Service Plan in 2020 and report back to the Infrastructure and Environment Committee.

FINANCIAL IMPACT

There are no direct financial implications resulting from the adoption of this report.

The financial impacts associated with increased invasive species management will be addressed in the Ravine Strategy Implementation Report presented at Executive Committee on January 23, 2020.

Any future capital and operating funding needs will be addressed as part of future year budget processes for City Council approval.

DECISION HISTORY

In June 2010, Parks, Forestry and Recreation presented Toronto's first canopy study to the Parks and Environment Committee as part of *Every Tree Counts: A Portrait of Toronto's Urban Forest*. The document was revised in 2013 based on further analysis of the original data and the results of a tree benefits report prepared by the United States Department of Agriculture (USDA) Forest Service.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2010.PE31.1>

In February 2013, City Council adopted the first Strategic Forest Management Plan which used the findings from the first canopy study. The Strategic Forest Management Plan recommended that tree canopy studies should be undertaken every ten years.

<http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2013.PE18.4>

COMMENTS

Background

Every Tree Counts: A Portrait of Toronto's Urban Forest was first published in 2010 and subsequently revised in 2013. Toronto's first-ever tree canopy assessment provided necessary baseline data to help the City make management decisions to meet urban forestry objectives. The 2008 canopy study made use of two distinct approaches to quantitatively determine the extent and distribution of urban forest cover: (1) the manual photo-interpretation of land cover class for approximately 10,000 randomly distributed sample points using 2009 leaf-on aerial imagery, and (2) a forest cover estimate derived through a semi-automated land cover classification process using 2007 leaf-on satellite imagery.

Toronto's canopy cover was estimated to be between 26.6 and 28 percent. The random point sampling method estimated 26.6 percent canopy cover while the semi-automated land cover classification method estimated 28 percent canopy cover. The semi-automated method included post-classification manual corrections by USDA Forest Service staff.

Tree canopy studies of this kind are an important part of the adaptive management cycle for Urban Forestry. They allow City staff to work with reliable data to adjust program activities that reflect the changing nature of the urban forest and evolving management issues.

Sustaining and Expanding the Urban Forest: Toronto's Strategic Forest Management Plan 2012-2022 sets out the required management actions to achieve a healthy and sustainable urban forest for future generations. The Plan included results of the first city-wide tree canopy assessment as documented in *Every Tree Counts: A Portrait of Toronto's Urban Forest*. The Plan identifies the goals and objectives for the growth and management of the urban forest resource, strategies to address immediate challenges, and a monitoring framework identifying indicators of success necessary to achieve long term goals.

In 2012, the Strategic Forest Management Plan identified six challenges to sustaining and expanding Toronto's urban forest:

- Forest Health Threats: The most severe pest species include Asian long-horned beetle, Emerald ash borer and European gypsy moth
- Tree Maintenance Requirements and Expectations: Urban Forestry maintains over 4 million trees on public property

- **Balancing Urbanization Impacts:** The city's growth has an impact on existing trees and the opportunities for the planting of new trees
- **Climate Change Impacts:** The increase in extreme weather events including frequent and intense storms and severe drought impacts the tree canopy
- **Recreational Pressures:** Increasing recreational pressures on forested natural areas have degraded the natural environment and are impacting sensitive native species.
- **Increasing Public Awareness:** Everything humans do can have an impact on trees and natural features resulting in a reduction of the ecological services they provide

Recognizing these challenges, the Strategic Forest Management Plan set out six strategic goals:

- **Increase Canopy Cover:** Protect, maintain and expand the urban forest to achieve a healthy, sustainable forest with canopy cover of 40 percent.
- **Achieve Equitable Distribution:** Achieve equitable distribution of the urban forest, increasing canopy where it is most needed.
- **Increase Biodiversity:** Increase biodiversity to improve urban forest resiliency and respond to climate change.
- **Increase Awareness:** Increase awareness of the value of trees, the natural environment and the sensitivity of these resources.
- **Promote Stewardship:** Promote stewardship and education of the multiple benefits of the urban forest, and build collaborative partnerships in expanding the forest.
- **Improve Monitoring:** Improve information management systems and enhance the ability to inventory, monitor and analyze the urban forest.

The Council-approved Strategic Forest Management Plan is a 10-year road-map that has guided Urban Forestry's planning and decision making since 2012. One of the recommendations in the Plan is to conduct city-wide canopy studies every 10 years using the latest technologies and industry best practices. The City of Toronto has completed its second tree canopy study. The study findings will be used to inform evidence-based decisions about ongoing urban forestry program planning and future program directions through relevant City strategies and initiatives.

2018 Tree Canopy Study - Methodology

The 2018 Tree Canopy Study sought to replicate the two methodologies used in the first canopy assessment in order to make comparative observations of changes in the urban forest. Urban Forestry hired BioForest/Lallemand Inc., KBM Resources Group and Dillon Consulting Limited to carry out the study.

The consultants used two methods to estimate canopy cover: (1) manual photo-interpretation of land cover class for 10,000 random distributed sample points using 2018 leaf-on satellite imagery, and (2) automated continuous land cover classification using the same 2018 leaf-on satellite imagery together with LiDAR (Light Detecting and Ranging).

The random point sampling method is a non-spatial approach best used for statistically reliable estimates and change assessment of land and canopy cover, making it possible to calculate the standard error associated with cover type distribution estimates. The

automated land cover classification method is best for mapping spatial extent and distribution of the forest canopy at the macro level. Accuracy of the classification outcomes cannot be calculated at different scales as it is virtually impossible to ground truth the land cover classification across large areas. In order to improve the accuracy of this approach, Toronto's Geospatial Competency Centre used 2018 satellite imagery and LiDAR to determine four of the eight land cover classes: tree, grass, bare earth and shrub cover. No post-classification manual correction was applied to the digital land cover estimate, making this approach fully automated.

In addition to the two canopy cover methodologies, structural and functional values of the urban forest were determined using field data collected from 407 permanent sample plots. Field data from the sample plots was entered into i-Tree Eco, a software developed by the United States Department of Agricultural (USDA) Forest Service. This software evaluates the field data to determine urban forest features and calculates the physical properties of the resources and the value of the benefits they provide. The sample plots represent a sample of the city's tree population and were first used in 2008 and again in 2018 to provide information about species distribution, size class distribution, overall tree health, and estimated ecosystem services. Data collected at each plot included land use, ground and tree cover, individual tree attributes such as species, height, diameter at breast height (dbh), and tree health.

The 2018 Tree Canopy Study provides a new analysis of the benefits provided by Toronto's street trees to complement the assessment of the city's entire urban forest. The consultant team performed a benefits analysis using data from the City's street tree inventory and i-Tree Eco software.

The 2018 Tree Canopy Study Technical Report, describing the methodology in full, can be found in Attachment 2 of this report.

2018 Tree Canopy Study - Summary of Findings

The 2018 Tree Canopy Study provides a snapshot of current urban forest conditions and measures environmental change. In addition to providing an estimate of Toronto's current canopy cover, the study provides information on tree population, species diversity, species distribution, condition, land cover, pervious and impervious surfaces, possible planting areas, ecosystem services and structural value.

A summary of the study findings are provided below.

Toronto's canopy cover and tree population have increased since 2008.

- On average, canopy increased by about 1.8 percent across Toronto from its 2008 range of 26.6 to 28 percent to the 2018 range of 28.4 to 31 percent over the ten-year study period.
- These ranges were produced using two methodologies: a random point sampling method and an automated land cover classification method.
- Toronto's tree population increased from 10.2 million to 11.5 million trees, an increase of 1.3 million trees over 10 years.
- Toronto's trees are estimated to provide annual ecosystem services worth more than \$55 million. These benefits include energy savings, carbon sequestration, pollution

removal and avoided runoff. These benefits have an annual value of about \$18.80 for each resident of the City of Toronto.

Street trees are making a significant contribution to the urban forest.

- Street tree condition has improved significantly from 49 to 74 percent, with a 25 percent increase in tree condition rating of good/excellent.
- Street trees contribute a proportionately greater amount of urban forest benefits than the urban forest as a whole. Street trees provide 19.4 percent, or \$1.363 billion, of the total \$7.04 billion structural value of the urban forest.
- Size class distribution has improved with more large trees, those with a diameter at breast height (dbh) measure of 45 centimetre and up, increasing from 12.5 to 16.3 percent of the street tree population; this will result in future increases in the value of ecosystem services.
- Street trees provide \$1.277 million dollars each year in ecosystem services including energy saving, carbon sequestration, pollution removal and avoided runoff.

The composition and condition of the urban forest has seen positive and negative changes.

- Species composition has changed slightly with more larger-growing species in the population. This means that the structural value of the urban forest will likely increase in the future.
- Open Space 1 lands (parks and ravines) have the highest proportion of native tree cover by land use category, remaining relatively stable since 2008, at 70 percent.
- The size class distribution of the urban forest has changed, with the proportion of small trees increasing in the population (trees under 15.2 centimetre dbh). This shift to a younger urban forest has the potential for long-term positive impacts on canopy growth and future ecosystem services.
- The overall condition of the urban forest has declined, with 70 percent of trees rated in good/excellent condition compared to 82 percent in 2008. A decrease in tree condition contributes to a decrease in ecosystem services.
- Open Space 1 lands (parks and ravines) saw an increase in invasive tree cover from 10 to 14 percent and an increase in invasive shrub cover from 15 to 32.5 percent, much of this is common buckthorn.

Impervious land cover is increasing across the city.

- The amount of impervious land cover increased by 1.4 percent over ten years, from 47.9 to 49.2 percent.
- Since 1999, impervious cover has been progressively increasing, by 3.6 percent, while pervious cover has decreased by 6.9 percent.
- The most land area converted from pervious to impervious cover is found on Single Family Residential lands, with a total of 349 hectares.

Urban Forestry has produced a public-friendly document, called CanopyTO, to share and communicate a summary the 2018 Tree Canopy Study findings. CanopyTO can be found as Attachment 1 to this report.

See Table 1 below for a summary of findings comparing 2008 and 2018 canopy assessment results.

Table 1: Comparison Table 2008-2018

Measure	2008	2018
Number of Trees	10.2 million	11.5 million
Urban Forest Canopy Cover	26.6 - 28%	28.4 - 31%
Total Leaf Area*	101,500 hectares	90,516 hectares
Structural Value	\$7.1 billion	\$7.04 billion
Ratio of Trees on Public / Private Land	40 / 60	45 / 55
Street Trees in Good or Excellent Condition	49%	74%
Gross Carbon Sequestration	46,700 tonnes	35,170 tonnes
Annual Pollution Removal	\$16.9 million	\$37.6 million
Annual Energy Savings	\$10.2 million	\$8.2 million
Total Annual Ecosystem Services	\$28.2 million	\$55.0 million
Urban Forest Trees in Good/Excellent Condition	82%	70%
Street Tree Structural Value	Not measured	\$1.363 billion
Street Tree Annual Ecosystem Services	Not measured	\$1.277 million

* Although total tree population increased, leaf area has decreased because the tree population is made up of younger trees. This factor influences structural value and ecosystem services.

Understanding the 2018 Tree Canopy Study Findings

The 2018 Tree Canopy Study presents data and information about broad changes and trends in Toronto's urban forest over a 10 year period. It does not provide a thorough analysis of the underlying cause-and-effect relationships. However, a few known factors can be assumed to have contributed to the outcomes of this comparative study.

Over the course of ten years, Toronto's tree population has expanded by over one million trees. The city's canopy cover increased by 1.8 percent despite facing significant environmental stress factors such as forest pests including Asian long-horned beetle, Emerald ash borer infestation, and European gypsy moth; the 2013 ice storm; and increasing impervious land cover. Toronto's street trees are healthier and more abundant and deliver proportionately more environmental services than the small share of the total tree population they represent. These advancements are a testament to continuous improvement in the City's proactive maintenance programs and consistent investment in urban forest expansion through tree planting and stewardship.

While some characteristics of Toronto's urban forest have improved not all trends are positive. Total leaf area of the urban forest has declined since 2008 and the average tree size has become slightly smaller. Overall tree condition appears to have declined as well. As a result of these shifts, Toronto's urban forest has slightly less structural value than it did in 2008. Invasive plant species constitute a serious threat to the future quality and resilience of Toronto's urban forest, particularly in ravines and other natural areas. The 2018 field survey results suggest that nearly a third of the understory shrub layer is composed of invasive species. Invasive tree species also now make up a larger share of the tree canopy in parks and ravines than they did in 2008. These trends

suggest the need for continued monitoring in ravine areas and increased investment in management activities.

Changes in canopy growth and impervious cover over the last ten years reflect the realities of meeting growth requirements while protecting and enhancing the natural environment. The City's Official Plan growth strategies are balanced with environmental sustainability objectives, including a sustainable urban forest. Building a successful city means making choices that improve the quality of life for its citizens and seizing opportunities to protect, restore, enhance and extend the natural heritage system through new developments or partnerships with other agencies and institutions.

To put Toronto's tree canopy results in a regional context, the findings from Toronto's tree canopy study are similar to those found by the city of Oakville which recently completed a ten-year comparative tree canopy assessment in 2015. In particular, Oakville saw an increase in invasive species across their city, validating that this trend is a widespread issue effecting the urban forest across the Greater Toronto Area.

In general, the results of the tree canopy study are encouraging. They are consistent with key management decisions guided by the Strategic Forest Management Plan and by Council-approved operating and capital budgets over the last ten years. Investment in Toronto's urban forest has grown from an annual budget of \$31.1 million in 2008 to \$68.7 million in 2018, for a total of \$605.6 million over ten years.

Toronto's urban forest management program is advancing in the right direction while the results recognize the need for continued investment to maintain and enhance a resilient, sustainable and equitable urban forest. A city with a well-planned and well-managed urban forest is vital to the quality of life in the city and supports climate change mitigation and adaptation, disaster risk reduction, ecosystems conservation, food security, poverty alleviation, and livelihood improvement.

Next Steps

The 2018 Tree Canopy Study provides a snapshot of current urban forest conditions and measures environmental change. City staff will continue to review the findings, analyze both positive and negative trends, and use them to inform ongoing Urban Forestry program planning and operational adjustments.

This new data will inform evidence-based decisions for future and ongoing Urban Forestry program planning and strategic resource allocation through revisions to the Urban Forestry Service Plan to be presented to the Executive Committee in 2020. Future program planning will also inform operating and capital budget requests starting with the 2021 budget cycle. In addition, study findings have already supported the Ravine Strategy Implementation Report to be presented to Executive Committee on January 23, 2020 and will inform other relevant City strategies and initiatives, such as the implementation of the Toronto Biodiversity Strategy, and TransformTO, the City's Climate Change Action Plan.

Efforts to expand Toronto's urban forest constitutes a valuable investment in the city's future. As demonstrated by trends in this ten-year comparative analysis, consistent and strategic investments in Urban Forestry programs are delivering measurable benefits to

the livability of the city. Many public and private agencies have a role in managing Toronto's urban forest. Future decisions to grow, protect, and enhance Toronto's urban forest will require partnerships, robust policies and a commitment to protect the growing space for urban forest expansion. Planning for the future of the urban forest will require balancing the needs of a growing human population and innovative strategies to maintain and expand the urban forest so that it continues to provide services and benefits to Toronto's residents.

CONTACT

Jason Doyle, Director, Urban Forestry, Parks, Forestry and Recreation
Tel: 416-392-1894 Email: Jason.Doyle@toronto.ca

Kim Statham, Manager, Forestry Policy and Planning, Parks, Forestry and Recreation
Tel: 416-392-6478 Email: Kim.Statham@toronto.ca

Connie Pinto, Program Standards and Development Officer, Urban Forestry, Parks, Forestry and Recreation
Tel: 416-392-0357 Email: Connie.Pinto@toronto.ca

SIGNATURE

Janie Romoff
General Manager, Parks, Forestry and Recreation

ATTACHMENTS

Attachment 1: CanopyTO
Attachment 2: 2018 Tree Canopy Study, Technical Report

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(Attached separately as a PDF)

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